Improving the quality of morbidity indicators in electronic health records in Swiss primary care

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Abstract: QUESTIONS UNDER STUDY: The FIRE Project established a standardised data collection to facilitate research and quality improvement projects in Swiss primary care. The project is based on the concept of merging clinical and administrative data. Since chronic conditions and multimorbidity are major challenges in primary care, in this study we investigated the agreement between different approaches to identify patients with chronic and multimorbid conditions in electronic medical records (EMRs). METHODS: A total of 60 primary care physicians were included and data were collected between October 2008 and June 2011. In total, data from 509594 consultations derived from 98152 patients were analysed. Chronic and multimorbid conditions were identified either by ICPC-2 codes or by the type of prescribed medication. We compared these different approaches regarding the completeness of the data to describe chronic conditions and multimorbidity of patients in primary care practices. RESULTS: The data showed a high correlation between the two morbidity schemes and both indicators apparently provide reliable measures of morbidity within practices. There was considerable variability of patients with chronic conditions across practices, irrespective of whether ICPC-2-diagnoses or prescribed drugs were used to code clinical encounters. Obvious discrepancies between diagnoses and therapies across major disease categories existed. CONCLUSIONS: This study describes the current situation of EMRs in terms of the ability to measure the burden of chronic conditions in primary care practices. The results illustrate a need of action for this specific topic and the results of this study will be incorporated into the functional specification of EMRs of a planned eHealth project in Swiss primary care.

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Improving the quality of morbidity indicators in electronic health records in Swiss primary care

A practical approach

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Summary

QUESTIONS UNDER STUDY: The FIRE Project established a standardised data collection to facilitate research and quality improvement projects in Swiss primary care. The project is based on the concept of merging clinical and administrative data. Since chronic conditions and multimorbidity are major challenges in primary care, in this study we investigated the agreement between different approaches to identify patients with chronic and multimorbid conditions in electronic medical records (EMRs).

METHODS: A total of 60 primary care physicians were included and data were collected between October 2008 and June 2011. In total, data from 509594 consultations derived from 98152 patients were analysed. Chronic and multimorbid conditions were identified either by ICPC-2 codes or by the type of prescribed medication. We compared these different approaches regarding the completeness of the data to describe chronic conditions and multimorbidity of patients in primary care practices.

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CONCLUSIONS: This study describes the current situation of EMRs in terms of the ability to measure the burden of chronic conditions in primary care practices. The results illustrate a need of action for this specific topic and the results of this study will be incorporated into the functional specification of EMRs of a planned eHealth project in Swiss primary care.

Key words: *primary health care; electronic medical records; data quality; Switzerland*

Introduction

In an earlier paper we described the FIRE Project, a data repository in the setting of Swiss primary care, and documented the implementation of a framework to collect data from electronic medical records (EMR) from individual practices [1]. The aim of the project is to set up a knowledge base that facilitates research and enhances quality of care. Similar projects have been launched in other countries, such as the CONTinuous morbidity registration Epidemiologic NeTwork (CONTENT) project in Germany [2].

There is a broad consensus that valid and reliable data are indispensable for quality initiatives, health services research and health policy decisions; however such data, especially from primary care settings are lacking in most countries. Merging data in the EMR recorded for administrative purposes with clinical data gathered during patient encounters may therefore provide an efficient way to build up a knowledge base regardless of whetherit will be used for quality issues, for example by calculating quality indicators, or for research purposes. With reference to reliability and validity, both routine and *de novo* data collection have inherent advantages and disadvantages, and merging the two data sources can cause additional problems. Depending on the source, the validity of the data may therefore vary substantially within EMRs since some items such as laboratory values are recorded automatically, whereas the validity of clinical information mainly depends on how physicians and their staff record the respective variables in the EMR.

This study focuses on clinical data and documents these issues using data from patients with chronic diseases in the FIRE database. The goal is to provide guidance for further development and implementation of EMRs in the setting of Swiss primary care and for chronic disease in particular. Chronic diseases and multimorbidity have significant medical and economic implications, and the availability of valid information about the epidemiological characteristics of such diseases is essential for physicians and the health system. We therefore compared the agreement between different approaches to identify patients with chronic and mul-

timorbid conditions in Swiss primary care practices based on data recorded in EMRs. In detail, we compared the ICPC-2 classification [3], a widely used system in primary care, with pharmaceutical cost groups (PCG) [4] and interpreted the results as indicators of completeness of the data and quality of coding.

Methods

The FIRE Project (Family Medicine ICPC-Research using Electronic Medical Records) established a standardised collection of data from EMRs to facilitate research in Swiss primary care [1]. Based on these data we designed a cross-sectional study and 60 primary care physicians, who were participating in the FIRE project on a voluntarily basis, were included. Eligibility criteria at the practice level were at least 100 patients treated and data were collected between Oct 2008 and June 2011. In total, data of 509594 consultations derived from 98152 patients were available for analysis.

The FIRE data cover patient demographics, vital signs, laboratory data, ICPC-2 codes [3] and type and dosage of prescribed medication at the level of individual consultations.

The ICPC-2 coding scheme was accepted by the WHO to classify the reason of encounter in the setting of primary or general practice. The coding structure is based on seven components including symptoms and complaints; diagnostic, screening and preventive procedures; medication, treatment and procedures; test results; administrative; referrals and other reasons for encounter; and diseases [3]. Prescription drugs are classified according to ATC/DDD coding, also established by the WHO. This coding structure is based on organs and systems on which drugs act and drugs are categorised into five different levels divided into 14 main groups [5].

Burden of morbidity at the practice level was determined by calculating the average number of chronic conditions per patient. These conditions were identified either by ICPC-2 codes or by type of prescribed medication. A set of specific ICPC codes was used to define chronicity from a diagnostic perspective [6] and the concept of pharmaceutical cost groups (PCGs) was applied to define chronicity from a therapeutic perspective [4]. For every consultation the number of both types of chronic conditions (according to ICPC or PCG) was determined and within each classification scheme patients were defined as chronic if at least one chronic condition was present. Completeness of these indicators was assessed by calculating the proportion of treatments for chronic conditions justified by a corresponding diagnosis documented during the same or an earlier consultation for the same patient. To achieve this task, diagnoses and treatments were linked at the patient level by assigning PCGs to corresponding ICPC chapters [4, 6]. Table 1 documents the respective associations.

PCGs could be assigned to ICPC chapters K, P, T, R, N, F, L, D and U. No one-to-one matching with PCGs was possible for the remaining ICPC chapters. Case histories of patients were established by sorting individual physician-patient encounters by date and treatment records were considered to be complete if a corresponding ICPC diagnosis was recorded during the same consultation or during an earlier consultation of the same patient (no time limits between initial diagnosis and treatment were set). Treatment records without a matched diagnosis were considered as incomplete. For each physician, the proportion of complete treatment records among all treatments within the same ICPC chapter was interpreted as an indicator of coding quality. ICPC and PCG based morbidity indicators were standardised for patient age and sex using linear regression. These standardised morbidity indicators allow comparison of burden of morbidity across practices. However standardisation procedures are not perfect and in a few practices standardisation resulted in negative values. Rank sum correlation coefficients (ρ) were used to document the respective relationships between the two coding schemes.

Results

A total of 509,594 consultations derived from 98,152 patients were recorded during the study period. On average a physician documented 19 consultations per work-day (median 19, min 6, max 39 consultations/day) with a range of 5 to 39 consultations. The average age of patients was 44.0 years and the proportion of consultations for female patients was 53.6% (53.0% of patients). Chronic conditions were diagnosed in 31.7% and 46.1% of all consultations based on ICPC-2 and PCGs respectively. Prevalence estimates of patients with chronic conditions across the two coding schemes are given in table 2. The average number of chronic conditions per patient at the practice level was 0.34 for ICPC-2 codes and 0.37 for PCGs. Correlation coefficients showed considerable and significant linear associations between the two indicators and moderate positive associations with age were present for both indicators. Negative relationships were observed between morbidity indicators and the proportion of female patients in practices (table 3).

Only minor changes were observed after morbidity indicators at the practice level were standardised for age and sex

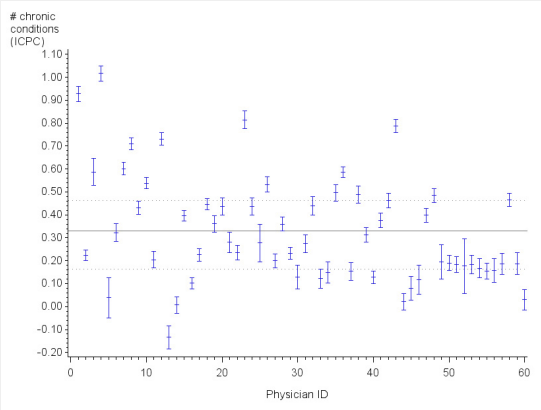

Figure 1

Variation of average number of ICPC based chronic conditions per patient across 60 primary care practices.

[a] The horizontal line denotes the overall averages of ICPC codes at the practice level, dotted lines the first and third quartile. Error bars show the 95% confidence interval of ICPC based morbidity estimates of practices.

of patients. Age and sex adjusted averages of chronic conditions were 0.36 chronic conditions per patient for PCGs and 0.33 chronic conditions per patient for ICPC codes. For both classification schemes, considerable variation of age and gender adjusted morbidity across practices was observed; the ratios between practices with maximal and minimal values were 7.39 for PCG and 7.61 for ICPC (fig. 1 and 2).

For the set of chronic conditions analysed in this study, the overall proportion of treatment records with a corresponding diagnosis was 64% (median 70%) and substantial differences between practices were observed, the lowest proportion was 0.5% and the highest was 100%. Variation was also present between ICPC chapters and highest proportions of complete records were seen for diabetes (chapter T: 74% complete records) and lowest for glaucoma (chapter F: 38% complete records) (table 4).

Physicians were categorised into quartiles based on the proportion of treatment records with a corresponding diagnosis. Age and gender adjusted averages of chronic conditions per patient at the practice level were calculated for both coding schemes across these quartiles. With reference to practices with less than 30.7% complete records (quartile 4), the data of practices with high proportions of complete records (>64.5%, quartile 1) indicated six-fold higher estimates for chronic conditions per patient for ICPC and 1.6 fold higher estimates for PCG (table 5).

Table 1: Classification of chronic conditions coded by PCG and corresponding ICPC chapters.

PCG Group		ICPC chapter
1	Coronary and peripheral vascular disease	K
2	Epilepsy	N
3	Hypertension	K
4	HIV/AIDS	–
5	Tuberculosis	–
6	Rheumatologic conditions	L
7	Hyperlipidemia	T
8	Malignancies	–
9	Parkinson's disease	N
10	Renal disease (including ESRD)	U
11	Cardiac disease/ASCVD/CHF	K
12	Diabetes	T
13	Glaucoma	F
14	Peptic acid disease	D
15	Cystic fibrosis	–
16	Transplantations	–
17	Respiratory illness, asthma	R
18	Thyroid disorders	T
20	Crohn's and ulcerative colitis	D
21	Pain and inflammation	–
22	Pain	–
23	Depression	P
24	Psychotic illness	P
25	Anxiety and tension	P

Table 2: Prevalence estimates of patients with chronic conditions using ICPC or PCG based coding procedures (total number of patients: 98,152).

ICPC Chapter	# patients		Prevalence		Difference
	ICPC	PCG	ICPC	PCG	
B	1,086	–	1.106%	–	–
D	2,355	193	2.399%	0.197%	2.203%
F	692	415	0.705%	0.423%	0.282%
H	871	–	0.887%	–	–
K	11,906	15,776	12.130%	16.073%	–3.943%
L	9,155	2,388	9.327%	2.433%	6.894%
N	2,065	1,940	2.104%	1.977%	0.127%
P	4,178	7,970	4.257%	8.120%	–3.863%
R	2,175	3,968	2.216%	4.043%	–1.827%
S	1,966	–	2.003%	–	–
T	7,485	3,756	7.626%	3.827%	3.799%
U	195	14	0.199%	0.014%	0.184%
W	36	–	0.037%	–	–
X	270	–	0.275%	–	–
Y	857	–	0.873%	–	–

Discussion

We analysed the consistency between ICPC-2 and PCGs as different coding schemes to describe the prevalence of patients with chronic conditions in 60 Swiss primary care practices. The data showed high correlation between the two coding schemes (ρ = 0.689) and both indicators apparently provide consistent measures of morbidity within practices. However, there was considerable variability between patients with chronic conditions across practices, irrespective of whether ICPC-2 -diagnoses or prescribed drugs (PCGs) were used to code clinical encounters.

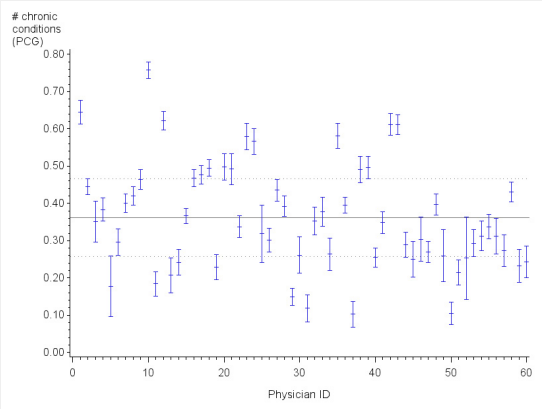

Figure 2

Variation of average number of PCG based chronic conditions per patient across 60 primary care practices.

[a] The horizontal line denotes the overall averages of PCG at the practice level, dotted lines the first and third quartile. Error bars show the 95% confidence interval of PCG based morbidity estimates of practices.

There were also obvious discrepancies between recorded diagnoses and therapies across major ICPC-2 chapters. Consistency of coding therapies with reference to a diagnosis that matched a specific prescription was generally unsatisfactory and substantial differences between practices were observed. The results also showed that poor coding directly affected morbidity estimates at the practice level implying that high coding quality is a necessary prerequisite when using electronic medical records for clinical decision making, health services research and health policy.

Practice variation is a well-known phenomenon and doctors can justifiably disagree about the appropriate forms of care and thus introduce variation associated with differences in "practice style" [7]. However, it is unreasonable to assume that practice style was the most important cause of practice variation observed in this study. Different quality of coding clinical data across practices is a more likely reason.

For various reasons Swiss primary care physicians have been slow to adopt electronic medical records [1] and causal factors of incomplete and poor coding are rooted in structural characteristics of the Swiss health system. Primary care is usually provided by physicians working in independent practices and services are reimbursed on a fee-for-service basis. This type of payment system is hindering the implementation of electronic medical records, as long as physicians are not compensated for the extra time

Table 3: Correlation coefficients of morbidity indicators and patient demographics at the practice level.

	ICPC	PCG
PCG	0.689 (<0.01)[a]	
Avg. patient age	0.473 (<0.01)	0.498 (<0.01)
% female patients	–0.320 (0.01)	–0.253 (0.05)

[a] p values, H_0: ρ = 0.

Table 4: Proportions of treatments with a corresponding diagnoses across eight ICPC chapters.

ICPC chapter	# physicians	Mean	Median	Min.	Max.	1. Quartile	3. Quartile
D	29[a]	67.17	66.05	5.26	100.00	54.00	87.73
F	23	38.09	32.89	0.53	100.00	19.01	71.43
K	60	67.75	73.58	4.94	88.93	58.44	79.90
L	44	44.12	46.86	0.79	85.71	31.46	63.30
N	50	39.68	31.86	0.72	83.33	23.78	58.16
P	55	45.86	46.24	2.13	80.83	36.65	51.74
R	55	53.62	56.15	2.33	83.56	49.01	61.78
T	57	73.62	75.57	1.72	100.00	69.76	87.24

[a] Different numbers of observations indicate that physicians treated patients with a different spectrum of ICPC chapters.

Table 5: Average number of chronic conditions per patient.

Proportion of		Chronic conditions ICPC			Chronic conditions PCG		
"Complete treatments"	# physicians	Mean	min	max	Mean	Min	max
Quartile 1 (>64.5%)	15	0.65	0.34	1.05	0.47	0.24	0.66
ICR[a] (30.7–64.5%)	30	0.30	0.06	0.65	0.35	0.06	0.74
Quartile 4 (<30.7%)	15	0.11	0.03	0.23	0.29	0.02	0.46
All	All	0.34	0.03	1.05	0.37	0.02	0.74

[a] ICR = interquartile range (quartiles 2 and 3).

needed to enter the data or no other forms of added value becomes visible to them. Adaption is also hindered by the fact that electronic health records have failed to provide convincing proof that they increase quality of care [8, 9]. From a scientific perspective there are inherent problems related to the fact that electronic medical records are designed to support decision in the care process and not to facilitate research.

However, only complete and correct records can reach their goal of having measurable effects on quality of care and facilitating research. Substantial efforts in research and education are therefore needed to realise these benefits within the FIRE project. We see two major strategies to accomplish this task.

Data integration

The first strategy is aimed at minimising the additional workload for physicians required to enter clinical data and the related codes. This can be achieved by linking consultation records with already existing datasets available within and beyond practices. Discrepancies between diagnose and therapies can be reduced by embedding functionality in software applications that allow linkage of therapies with a corresponding diagnosis at data entry. Integration of clinical and administrative records collected for billing purposes can also be improved. Such linked data would provide the correct denominator needed to address research questions related to health policy decisions beyond issues of individual patient care. Furthermore, the integration of clinical records with external record systems such as laboratory data, referred procedures and adverse drug reactions should be facilitated in order to eventually achieve real time decision support. Essential elements required for this task are shared implementation of anonymous patient identifiers across all involved parties and protected peer to peer communication protocols to ensure compliance with data protection laws. However, progress to standardise patient identifiers and secure communication protocols has been slow mostly due to lack of interest and difficulties to find incentives for involved parties beyond administrative needs [10]. Most efforts to improve integration of the data are essentially aimed at better control of source systems, since data verification and standardisation at this level is achieved with a fraction of the effort needed than for end-users. This task, however, appears nearly impossible within the highly fragmented setting of Swiss health care characterised by small scale and non-integrated systems of providers with little purchasing power. Professional organisations have to therefore reinforce their efforts to convince vendors of practice software to include the respective functionality into their applications. Coordinated implementation of software certification issued by physician organisations appears to be a practical solution to approach this issue.

Feedback, training and support

Feedback about data quality tailored to the specific needs of physicians and training physicians, including their staff, to code clinical encounters are effective methods to improve the quality of electronic patient records. We recently implemented an automated tool that generates individualised reports for each physician. These reports mirror the clinical activity of physicians and provide information that allows comparison of data quality indicators between peers. Reports are generated on a monthly basis and are mailed to physicians through a dedicated email system. The next phase of the project is therefore focused on refining this report tool. Issues of validity and reliability of coding have to be discussed and agreed upon with involved physicians. A pragmatic definition of a treatment episode is another topic that needs to be resolved in the same context. Many diagnostic codes are entered without an immediate therapeutic decision and linking therapies with corresponding diagnoses during following consultations can be difficult, and we have to examine the effect of varying paths of coding clinical encounters across different software systems. Furthermore, periodical meetings and specific training sessions with participating physicians have been organised in the past. However, there is currently no formal assessment in place that investigates the impact on coding quality of these sessions.

Strengths and limitations

Our study has several strengths and limitations that are important to note. We used coding for prescribed drugs as the reference and interpreted the consistency with a corresponding ICPC-2 diagnosis as an indicator of coding quality. This "treatment based approach" is clearly a strength of this project as it excludes patients from the validation process where primary care physicians make a first diganoses but refer patients to a specialist for further treatment (e.g., glaucoma). This approach also has limitations as it only provides relative estimates of completeness and correctness of EMRs. Absolute measures would require a comparison with a gold standard such as paper or other consultation records. Gold-standard comparisons are, however, beyond the resources currently available for this project, which was based on voluntary participation of GPs. We nonetheless consider our method as a pragmatic way for internal validation of coding morbidity in the setting of primary care as it seems unlikely that physicians prescribe medication for chronic conditions not justified by a corresponding diagnosis.

Another limitation relates to the fact that only a few conditions and broad disease categories could be studied. Most drugs can be prescribed for multiple conditions and we had to limit our analysis to prescriptions that are specific to a particular disease. Coding quality for important disease such as malignancies could not be established and the application of our results for clinical research is limited as disease categories were too general.

Further limitations refer to external validity. The study was restricted to a convenience sample of 60 physicians with explicit interests in recording information electronically. All physicians participated on a voluntary basis and generalisation of results is therefore difficult. Nevertheless many characteristics like age, practice size, gender and geographic location of the study practices match well with the corresponding average of GP practices in the German speaking part of Switzerland and it is also important to note that participating physicians represent a large proportion of physicians currently using EMRs in Swiss primary care. This is worthwhile as we consider the broader implement-

ation of EMRs as non-stoppable on-going process in the Swiss health system and participating physicians are considered as trendsetters for future colleagues.

Conclusions

This study describes the current situation of EMRs from a utility perspective to measure the burden of chronic conditions in primary care practices. The results illustrate a need of action for this specific topic embedded within a larger domain of technology, service provision and clinical medicine as defined by federal strategies to improve eHealth in Swiss health care [11].

The results of this study will be directly incorporated into the functional specification of EMRs of a currently planned eHealth project in Swiss primary care aimed to facilitate the integration of services through optimising the flow of information across care providers. However, without additional resources for research and support it will remain difficult to reach these goals.

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Figures (large format)

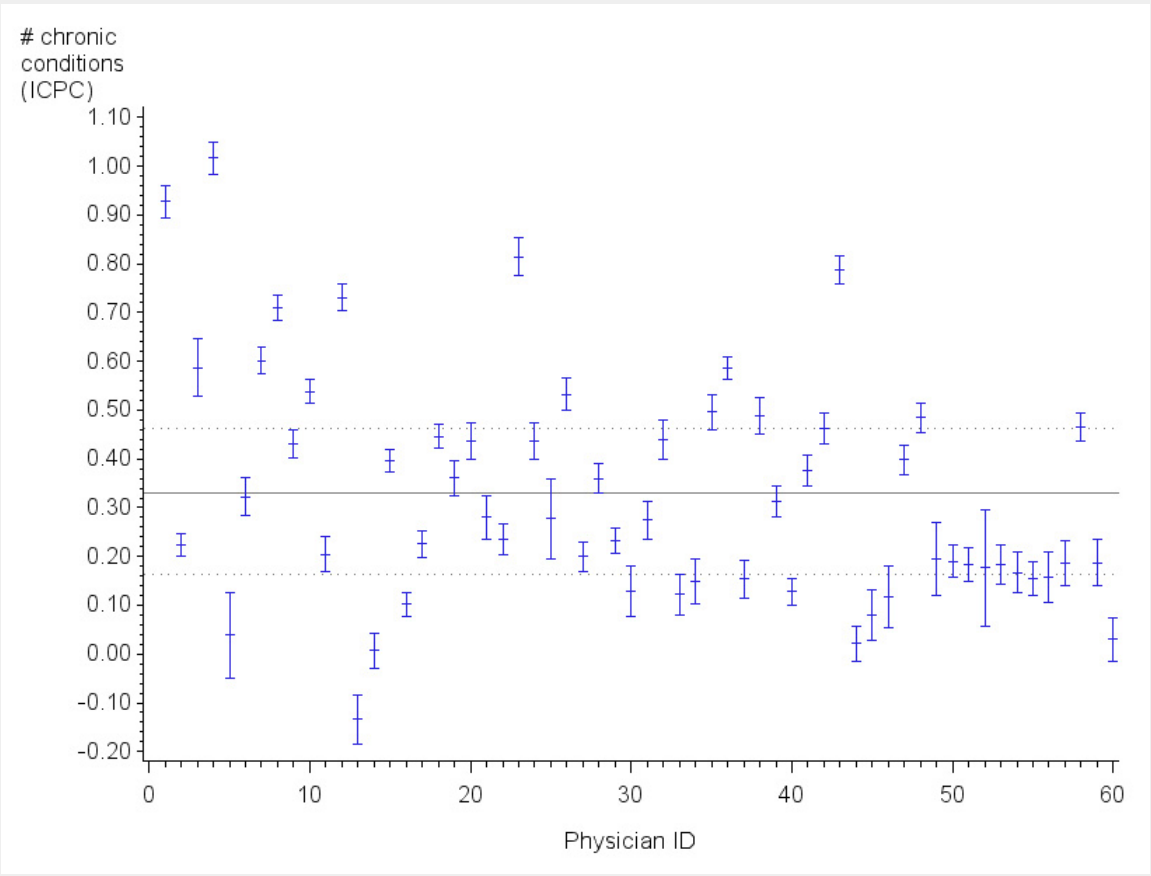

Figure 1

Variation of average number of ICPC based chronic conditions per patient across 60 primary care practices.
[a] The horizontal line denotes the overall averages of ICPC codes at the practice level, dotted lines the first and third quartile. Error bars show the 95% confidence interval of ICPC based morbidity estimates of practices.

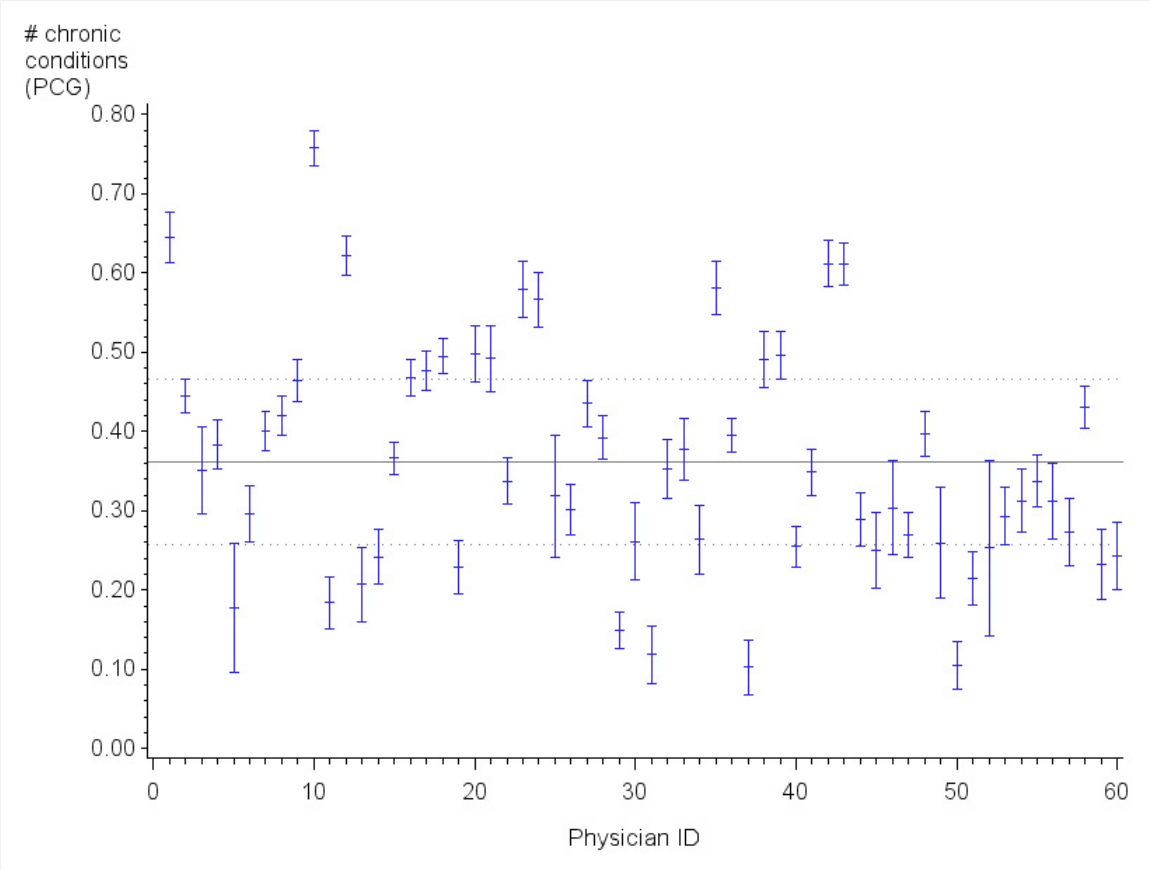

Figure 2

Variation of average number of PCG based chronic conditions per patient across 60 primary care practices.

[a] The horizontal line denotes the overall averages of PCG at the practice level, dotted lines the first and third quartile. Error bars show the 95% confidence interval of PCG based morbidity estimates of practices.